# Indian Health Service
# Sanitation Facilities Construction Program
# Wastewater Lagoon Operation & Maintenance

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# Indian Health Service
# Sanitation Facilities Construction Program

Executive Branch
(Federal Govt.)

Department of Health
& Human Services

U.S. Public Health Service

Operating
Divisions /
Agencies

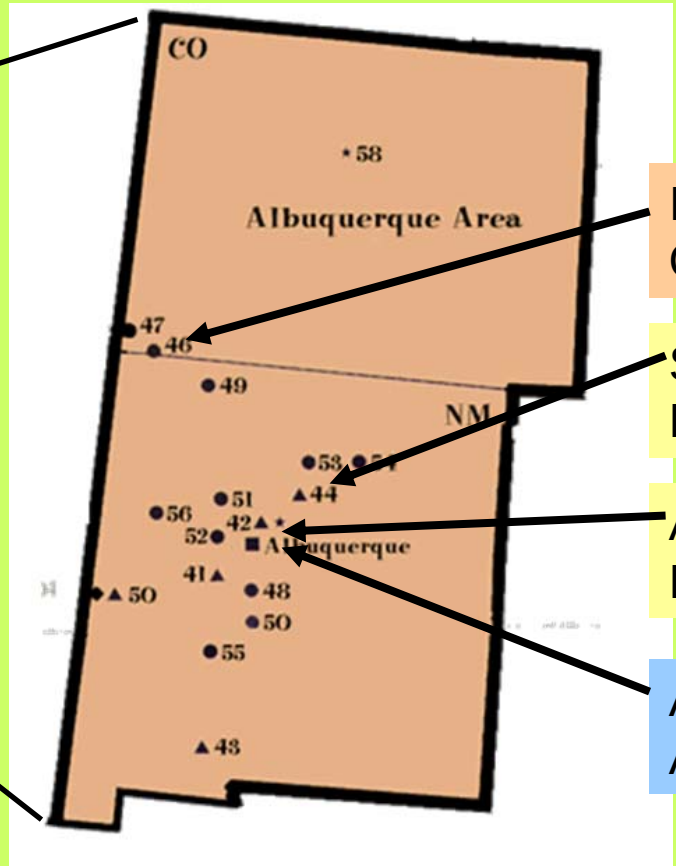
- Indian Health Service
- Center for Disease Control & Prevention (CDC)
- Food & Drug Administration (FDA)
- National Institutes of Health (NIH)
- 9 Others (13 total)

**Who Are We?**

Surgeon General Dr. Regina Benjamin is the Head of the Public Health Service

# Indian Health Service
# Sanitation Facilities Construction Program

Albuquerque Area IHS:


SFC Offices

Ignacio Field Office

Santa Fe District Office

Albuquerque District Office

Albuquerque AREA Office

# Wastewater Lagoon Systems Overview

## Why Do We Use Lagoons for Wastewater Treatment?

- Operation and Maintenance Cost is Low
- To match technical and financial capacity of the utility

### Advantages of Lagoon Systems

- Low O&M Cost
- Financial & Technical capacity required is low
- Low operator certification level (Level 1)
- Ability to handle shock loads

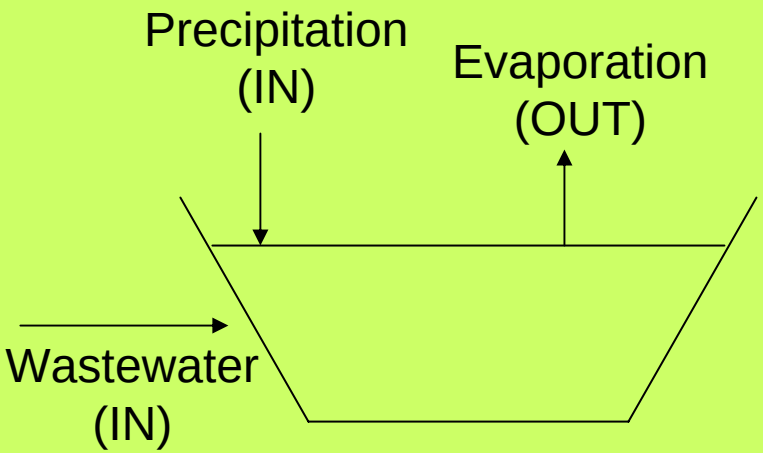
### Disadvantages of Lagoon Systems

- Odors
- Aesthetics
- Large land area required
- Little control over treatment process
- Mosquitos

# Wastewater Lagoon Systems Overview

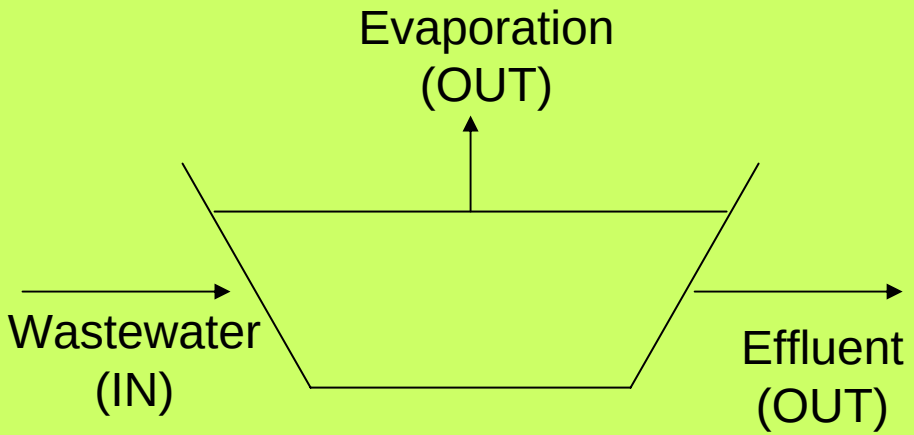
TYPES OF LAGOON SYSTEMS (Hydraulically):

## A. Total Retention Lagoon System




No NPDES Permit Required

## B. Discharging Lagoon System




NPDES Permit Required if discharging to water body

# Wastewater Lagoon Systems Overview

Discharging Lagoon Systems

Typical Methods of Discharge:

A: Direct discharge to river (NPDES Permit Required)

B. Discharge to percolation cell, wetland, or land application system (EPA NPDES Permit may NOT Required)

# Wastewater Lagoon Systems Overview

Discharging Lagoon Systems

Typical Methods Disinfection:

A: Chlorination

B. Chlorination/Dechlorination

C. UV Disinfection – typically wastewater from lagoons isn't clear enough for UV to be effective without some type of filtration

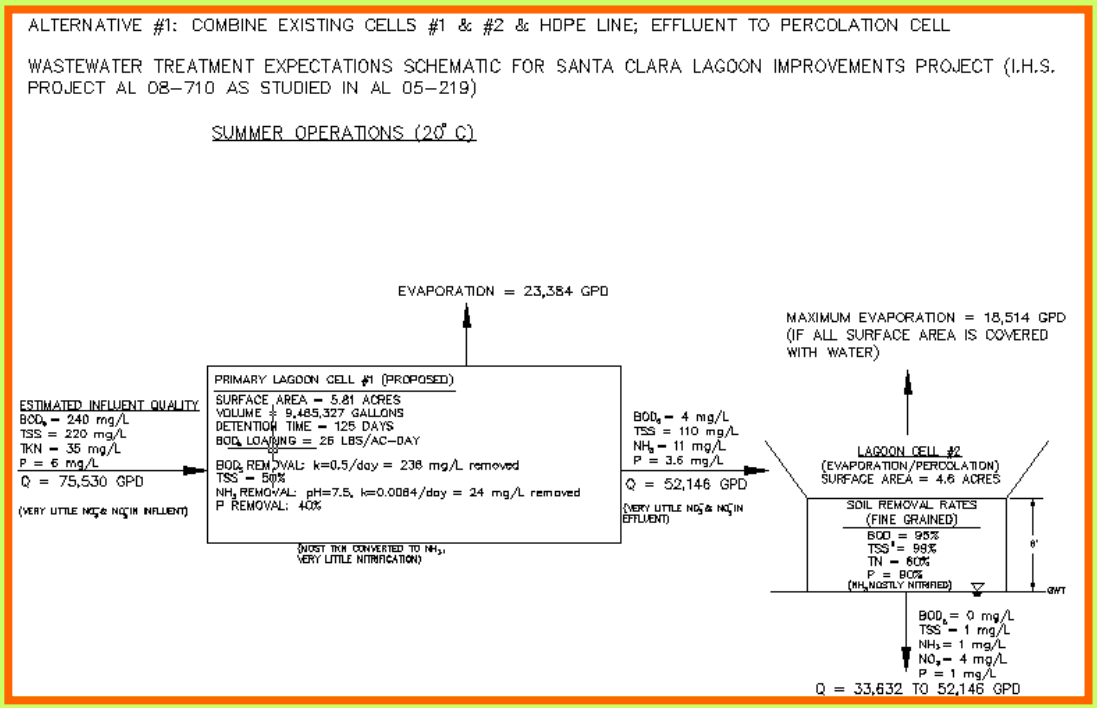
D. Ozone

# Wastewater Lagoon Systems Overview

Discharging Lagoon Systems:

<u>Percolation Cell Design Considerations</u>

- depth to groundwater
- Soil conditions; percolation rate
- Wastewater treatment quality prior to reaching groundwater
- Permit required?  Class V Injection Well?




# Wastewater Lagoon Systems Overview

Discharging Lagoon Systems:

Land Application System Design Considerations

- Drip irrigation vs. spraying sprinkler irrigation
- Wastewater Quality
- Crop Selection
- Soil conditions
- Storage capacity of lagoon to get through winter months
- Limit site access; signage
- Permit required?

**Table 1. Approved Uses for Reclaimed Wastewater by Class**

| Class of Reclaimed Wastewater | Approved Uses |
|---|---|
| Class 1A | All Class 1 uses. *No setback limit* to dwelling unit or occupied establishment. |
| | Backfill around potable water pipes |
| | Irrigation of food crops[1] |
| Class 1B | Impoundments (recreational or ornamental) |
| | Irrigation of parks, school yards, golf courses [2] |
| | Irrigation of urban landscaping [2] |
| | Snow making |
| | Street cleaning |
| | Toilet flushing |
| | Backfill around non-potable piping |
| Class 2 | Concrete mixing |
| | Dust control |
| | Irrigation of fodder, fiber, and seed crops for milk-producing animals |
| | Irrigation of roadway median landscapes |
| | Irrigation of sod farms |
| | Livestock watering |
| | Soil compaction |
| Class 3 | Irrigation of fodder, fiber, and seed crops for non-milk-producing animals |
| | Irrigation of forest trees (silviculture) |

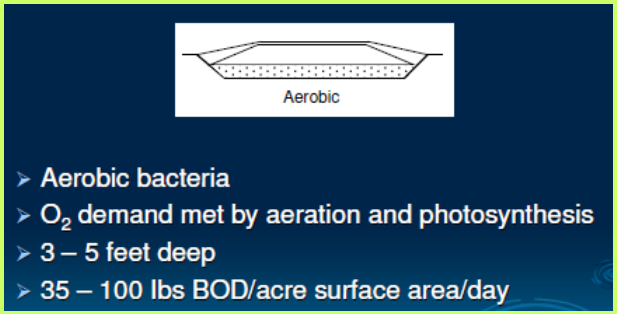
NMED Policy for the Above Ground Use of Reclaimed Domestic Wastewater

| | | | | | |
|---|---|---|---|---|---|
| Class 3 | $BOD_5$ | 30 mg/l | 45 mg/l | 3-hour composite for major WWTP[5]; Grab sample for minor WWTP | 1 test per week for major WWTP; 1 test per month for minor WWTP |
| | TSS | 75 mg/l | 90 mg/l | 3-hour composite for major WWTP; Grab sample for minor WWTP | 1 test per week for major WWTP; 1 test per month for minor WWTP |
| | Fecal Coliform[2] | 1,000 organisms per 100 ml[3] | 5,000 organisms per 100 ml[4] | Grab sample at peak hourly flow | 1 test per week for major WWTP; 1 test per month for minor WWTP |
| | TRC or UV Transmissivity | Monitor Only | Monitor Only | Grab sample or reading at peak hourly flow | Record values at peak hourly flow |

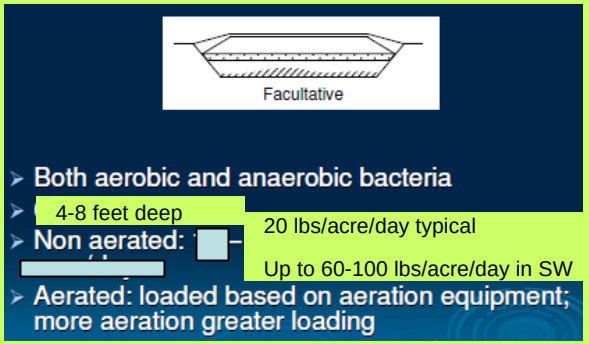
# Wastewater Lagoon Systems Overview

## TYPES OF LAGOON SYSTEMS (Treatment Types):

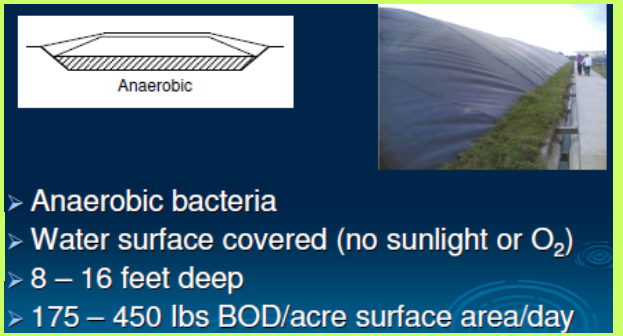
Aerobic: typical for domestic WW (aerobic treatment)




Facultative: typical for domestic WW (aerobic & anaerobic treatment)




Anaerobic: used for high strength WW (anaerobic treatment)



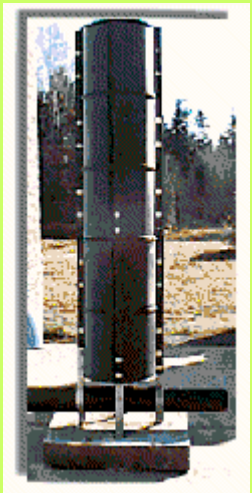

# Wastewater Lagoon Systems Overview

Aerobic Lagoon Systems:

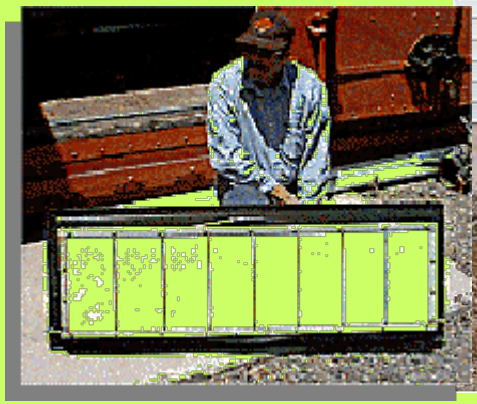
- Makes treatment more efficient than facultative
- Can decrease the footprint of the system vs. facultative
- typically discharge
- Try to keep minimum [DO] ≥ 2 mg/L
- Fine bubble aerators and surface aspirating aerators are most common in lagoon systems

Surface Aspirating Aeration: aeration equipment floats on lagoon surface and aerates lagoon

Coarse Bubble Aeration: not as efficient as fine bubble



Fine Bubble Aeration: more efficient than coarse bubble



# Wastewater Lagoon Systems Overview

## How Facultative Lagoon Systems Work

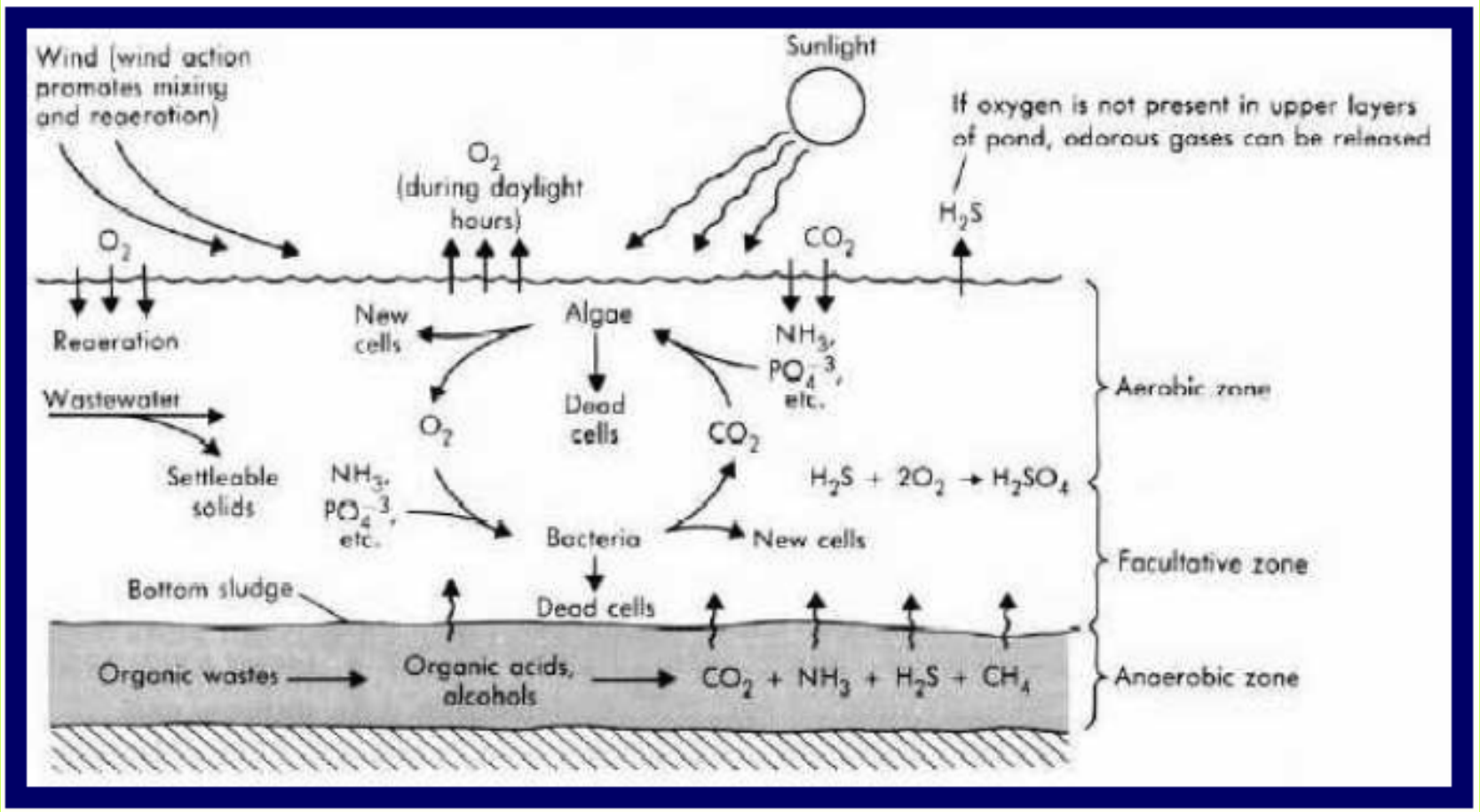



**Fig. 4 Operation of the facultative pond (Tchobanoglous and Schroeder 1987).**

# Wastewater Lagoon System Design

## Total Retention Lagoon System: Typically lined with HDPE Liner

Wastewater In + Precipitation In = Evaporation Out + Storage

- Need wastewater flow data projected for the design life of the lagoon system
- Need evaporation data for your area
- Do mass balance to size the lagoon system (how many acres ?)

**Picuris Lagoon Improvements**
**Design Spreadsheet**
**Total Retention Lagoon System**

**PROJECT NAME**
**LAGOON WATER BALANCE DATA - TOTAL RETENTION**

Notes:
1. Pan Evaporation used
2. Rainfall data from Penasco Station
3. Evaporation estimated by averaging the evaporation measured at Abiquiu Lake and Eagle Nest Lake

| ASSUMPTIONS | |
|---|---|
| influent [BOD] (mg/L) = | 220 |

| BOD Loading Calculations | |
|---|---|
| Size of 1st Lagoon Cell (acres) = | 2 |
| BOD Load on First Cell (#/acre/day) | 23 |

Less than 20 lbs/ac-day is desireable, but 60-100 lbs/ac-day is possible in the Southwestern US

***CALCULATED SIZING***

| | | | | |
|---|---|---|---|---|
| INFLOW TO LAGOON = | 25,000 gpd | = | 27.6219 | acre-in/month |
| TOTAL LAGOON SURFACE AREA = | 7.33 acres | = | 319,119 | Square feet |
| AVERAGE MONTHLY APPLICATION RATE = | 3.77 inches/month | | | |

| | *NEGATIVE FLOW* | | | *ADDITIONAL FLOW* | | | | FREEBOARD |
|---|---|---|---|---|---|---|---|---|
| | EVAPORATION | PERCOLATION | TOTAL | PRECIPITATION | WASTEWATER | TOTAL | VOLUME | CUMULATIVE |
| MONTH | (in.) | (in.) | LOSSES (in) | (in.) | INFLOW (in) | INFLOW (in) | OVERFLOW (in) | OVERFLOW (in) |
| *JAN* | 0.00 | 0.00 | 0.00 | 0.58 | 3.77 | 4.35 | 4.35 | 4.35 |
| *FEB* | 0.00 | 0.00 | 0.00 | 0.55 | 3.77 | 4.32 | 4.32 | 8.67 |
| *MAR* | 3.03 | 0.00 | 3.03 | 0.82 | 3.77 | 4.59 | 1.56 | 10.23 |
| *APR* | 6.17 | 0.00 | 6.17 | 0.82 | 3.77 | 4.59 | -1.58 | 8.65 |
| *MAY* | 8.81 | 0.00 | 8.81 | 1.19 | 3.77 | 4.96 | -3.85 | 4.80 |
| *JUNE* | 9.61 | 0.00 | 9.61 | 0.97 | 3.77 | 4.74 | -4.87 | -0.07 |
| *JULY* | 8.80 | 0.00 | 8.80 | 1.43 | 3.77 | 5.20 | -3.59 | -3.66 |
| *AUG* | 7.39 | 0.00 | 7.39 | 1.90 | 3.77 | 5.67 | -1.71 | -5.38 |
| *SEPT* | 6.27 | 0.00 | 6.27 | 1.33 | 3.77 | 5.10 | -1.16 | -6.54 |
| *OCT* | 4.81 | 0.00 | 4.81 | 1.19 | 3.77 | 4.96 | 0.16 | -6.39 |
| *NOV* | 1.57 | 0.00 | 1.57 | 0.89 | 3.77 | 4.66 | 3.10 | -3.29 |
| *DEC* | 1.11 | 0.00 | 1.11 | 0.63 | 3.77 | 4.40 | 3.29 | 0.00 |

| Pueblo of Picuris | | |
|---|---|---|
| Wastewater Flow Projections | | |
| # of homes = | | 86 |
| $Q_{avg}$ (gpd) = | | 16500 |
| $Q_{avg}$ per home (gpd) = | | 192 |
| Year | # homes (2% growth) | Projected Average Daily Wastewater Flow (gpd) |
| 2009 | 86 | 16,500 |
| 2010 | 87.7 | 16,830 |
| 2011 | 89.5 | 17,167 |
| 2012 | 91.3 | 17,510 |
| 2013 | 93.1 | 17,860 |
| 2014 | 95.0 | 18,217 |
| 2015 | 96.8 | 18,582 |
| 2016 | 98.8 | 18,953 |
| 2017 | 100.8 | 19,332 |
| 2018 | 102.8 | 19,719 |
| 2019 | 104.8 | 20,113 |
| 2020 | 106.9 | 20,516 |
| 2021 | 109.1 | 20,926 |
| 2022 | 111.3 | 21,345 |
| 2023 | 113.5 | 21,771 |
| 2024 | 115.7 | 22,207 |
| 2025 | 118.1 | 22,651 |
| 2026 | 120.4 | 23,104 |
| 2027 | 122.8 | 23,566 |
| 2028 | 125.3 | 24,037 |
| 2029 | 127.8 | 24,518 |

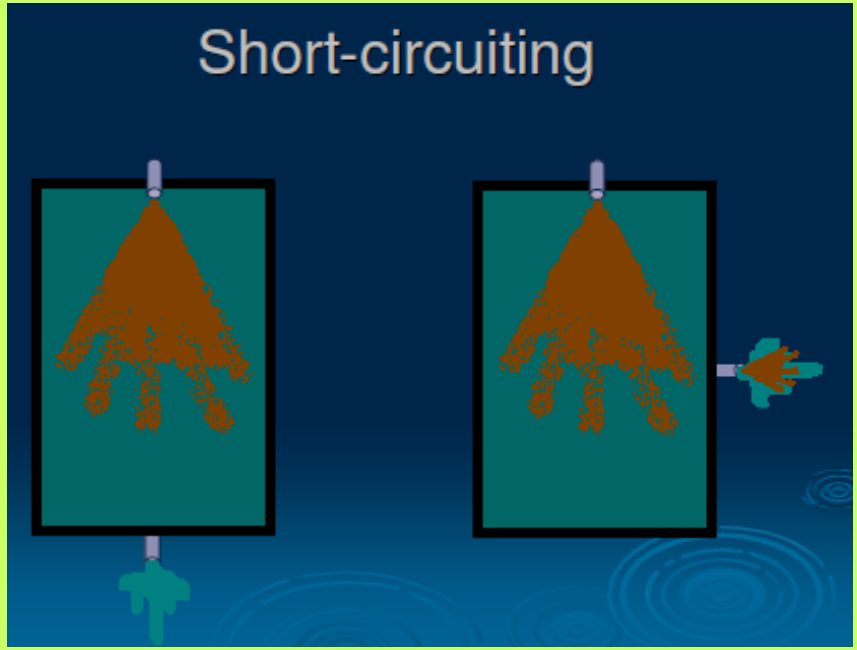
# Wastewater Lagoon System Design

## Aerobic & Facultative Lagoon Systems:

- Obtain wastewater quality data (BOD, TSS, N, & P at a minimum)
- Size 1st lagoon cell so that BOD loading is ≤ 20 mg/L (may be able to go up to 60 to 100 mg/L in Southwest where freezing doesn't occur) for Facultative Treatment; higher for Aerobic treatment (based on aeration equipment manufacturer's literature)

Configuration:

- Multiple cells for operational flexibility
- Set inlets and outlets to maximize retention time and reduce short circuiting



# Wastewater Lagoon System Design

## Typical Design Issues and solutions

Short Circuiting

Problem:

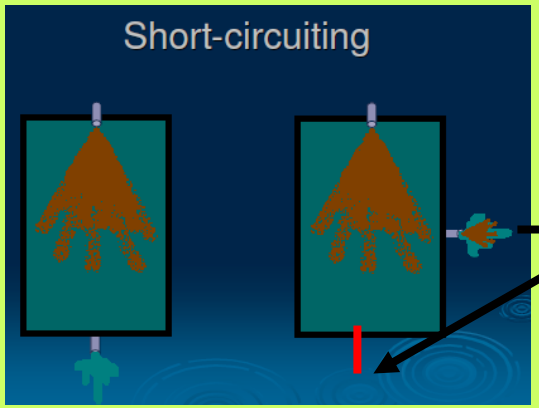
•Decreased retention time, thus treatment

Short Circuiting

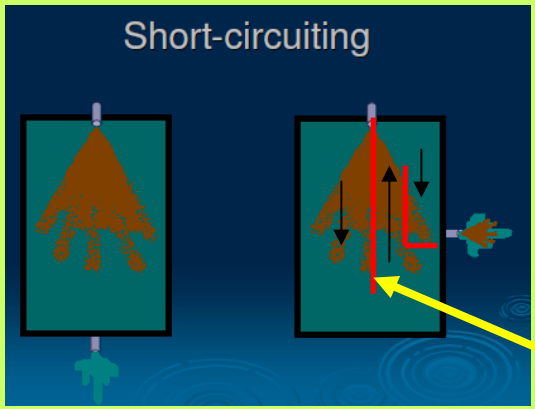
Can correct by:

•Changing piping configuration

•Installing baffles




Move outlet piping




Install baffles

# Wastewater Lagoon System Design

## Typical Design Issues and solutions

BOD Overloading of Primary Cell

Problems:

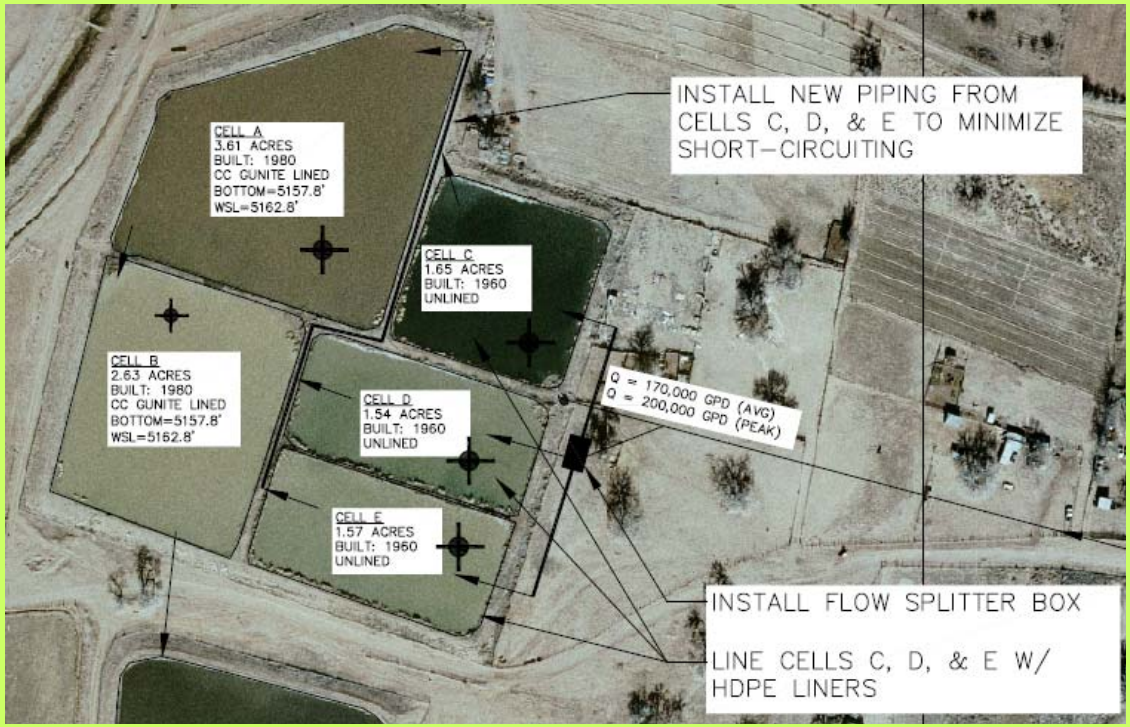
- Changes cell from facultative towards anaerobic
- Caused odors

BOD Overloading of Primary Cell

Can correct by:

- Increasing size of primary cell
- Splitting influent wastewater over more cells
- Aeration; perhaps pond circulators

Split flow from 1 cell to 3 cells or combine 3 cells into 1 (example)




# Wastewater Lagoon System Design

## Typical Design Issues and solutions

Lagoon Overflows

Problems:

•Creates a public health issue

Lagoon Overflows

Can correct by:

•Increasing size of lagoon system

•Reducing inflow to lagoon system

•Discharging

# Wastewater Lagoon System Design

## Typical Design Issues and solutions

Lagoon Empty (Percolating)

Problems:

•Wastewater seeping into ground with little or no treatment

•Possible groundwater contamination (nitrates, ammonia, BOD, etc.)

Lagoon Empty (Percolating)

Can correct by:

•Installing lagoon liner

# Wastewater Lagoon System Operation & Maintenance

Aerobic Lagoon Systems Only:

A. Fine/Course Bubble Aeration
   - •Air compressor maintenance
   - •Air diffuser maintenance
   - •Air piping maintenance
   - •Ensure even distribution of bubbles
   - •Clearing clogged diffusers

B. Surface Aspirating Aeration
   - •Mechanical equipment maintenance (based mostly on manufacturer's recommendations)

# Wastewater Lagoon System Operation & Maintenance

Facultative and Aerobic Lagoons:

- Weed Control – must be cut; limits aeration by cutting down wind; permit for pesticides
- Flow Measurement
- Sludge Measurement – sludge judge and row boat; pump when sludge depth is > 1/3 depth of lagoon
- Exercise transfer structure valves
- Know how the wastewater was DESIGNED to flow through your system and ensure that it is

# Wastewater Lagoon System Operation & Maintenance

## Discharging Lagoons:

A. Permit Requirements

- •Wastewater Quality Testing (continuous sampler vs. grab samples)
- •Flow Measurement (discharge volume)
- •When does permit allow discharge (continuous vs. timed releases)
- •Disinfection?
- •Discharge Monitoring Reports (DMR's)


## Discharging Lagoons:

A. Typical Testing Parameters for NPDES Permits

- •BOD, TSS, P, $NH_3$, Fecal Coliforms
- •Others (pH, temp, DO, alkalinity, etc.)

# Wastewater Lagoon System Operation & Maintenance

## Daily Inspections

A. Typical Permit Requirements

- Weekly inspection
- Discharge status
- Freeboard measurement
- Presence of animal burrows
- Erosion issues
- Vegetation
- Date/time of inspection
- Initials/name of inspector
- Corrective actions

# Wastewater Lagoon System Operation & Maintenance

EPA Self Inspection Booklets

## January

**Sample Requirements:**

- flow measurements
  instantaneous
- pH samples
  tested within 15 minutes
- BOD samples
  tested within 48 hours &
  stored below 6º C
- TSS samples
  tested within 7 days &
  stored below 6º C

**Self Inspection: January**

| Day | Leakage through berm? | Animal burrows in berm? | Excessive berm erosion? | Rooted plants in water? | Berms need mowing? |
|---|---|---|---|---|---|
| 1 | Y N | Y N | Y N | Y N | Y N |
| 2 | Y N | Y N | Y N | Y N | Y N |
| 3 | Y N | Y N | Y N | Y N | Y N |
| 4 | Y N | Y N | Y N | Y N | Y N |
| 5 | Y N | Y N | Y N | Y N | Y N |
| 6 | Y N | Y N | Y N | Y N | Y N |
| 7 | Y N | Y N | Y N | Y N | Y N |
| 8 | Y N | Y N | Y N | Y N | Y N |
| 9 | Y N | Y N | Y N | Y N | Y N |
| 10 | Y N | Y N | Y N | Y N | Y N |
| 11 | Y N | Y N | Y N | Y N | Y N |
| 12 | Y N | Y N | Y N | Y N | Y N |
| 13 | Y N | Y N | Y N | Y N | Y N |
| 14 | Y N | Y N | Y N | Y N | Y N |
| 15 | Y N | Y N | Y N | Y N | Y N |
| 16 | Y N | Y N | Y N | Y N | Y N |
| 17 | Y N | Y N | Y N | Y N | Y N |
| 18 | Y N | Y N | Y N | Y N | Y N |
| 19 | Y N | Y N | Y N | Y N | Y N |
| 20 | Y N | Y N | Y N | Y N | Y N |
| 21 | Y N | Y N | Y N | Y N | Y N |
| 22 | Y N | Y N | Y N | Y N | Y N |
| 23 | Y N | Y N | Y N | Y N | Y N |
| 24 | Y N | Y N | Y N | Y N | Y N |
| 25 | Y N | Y N | Y N | Y N | Y N |

# References

- EPA
- Internet Sources
- IHS SFC Handbook II:  Project Planning & Engineering

# Questions?

http://www.dsfc.ihs.gov

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